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WAIST CIRCUMFERENCE

AS A SIGNIFICANT RISK FACTOR FOR

CORONARY ARTERY DISEASE IN FEMALES

DISSERTATION SUBMITTED FOR

MD DEGREE (BRANCH I) GENERAL MEDICINE

MARCH 2008

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

CERTIFICATE

This is to certify that this dissertation titled "**WAIST CIRCUMFERENCE AS A SIGNIFICANT RISK FACTOR FOR CORONARY ARTERY DISEASE IN FEMALES"** submitted by **DR.ROOBY. E.H.** to the faculty of general medicine, The Tamilnadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of MD degree Branch I General Medicine, is a bonafide research work carried out by her under our direct supervision and guidance.

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This is submitted to the **Tamilnadu Dr. M.G.R Medical University** Chennai, in partial fulfillment of the regulations for the award of MD degree (Branch I) General Medicine.

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CONTENTS

1.	INTRODUCTION	1
2.	REVIEW OF LITERATURE	3
3.	AIM OF THE STUDY	26
4.	MATERIALS AND METHODS	27
5.	STATISTICAL ANALYSIS	32
6.	DISCUSSION	55
7.	SUMMARY	68
8.	CONCLUSION	70
9.	APPENDIX	
	BIBLIOGRAPHY	
	GLOSSARY	
	PROFORMA	
	MASTER CHART	

GLOSSARY

BMI	-	Body Mass index
BP	-	Blood Pressure
CAD	-	Coronary Artery Disease
CHD	-	Coronary Heart Disease
CM	-	Chylomicrone
CRP	-	C Reactive Protein
CVA	-	Cerebro Vascular Accidents
CVD	-	Cardio Vascular disease
DM	-	Diabetes Mellitus
DBP	-	Diastolic Blood Pressure
ECG	-	Electro Cardiogram.
EF	-	Ejection Fraction
F/H	-	Family History
HT	-	Hypertension
HDL	-	High Density Lipoprotein
HC	-	Hip Circumference
IR	-	Insulin Resistance
LDL	-	Low Density Lipoprotein
Lp (a)	-	Lipoprotein (a)

MI	-	Myocardial infarction
MS	-	Metabolic Syndrome
NCEP – ATP III	-	National Cholesterol Education programme. Adult Treatment Panel - III
IDF	-	International Diabetic Federation
OCP	-	Oral Contraceptive Pill
PI	-	Physical Inactivity
SBP	-	Systolic Blood Pressure
TC	-	Total Cholesterol
TG	-	Triglyceride
VLDL	-	Very Low Density Lipoproteins
WC	-	Waist Circumference
WHO	-	World Health Organisation
WHR	-	Waist Hip Ratio

INTRODUCTION

In today's world, most of the deaths are attributable to non-communicable diseases and just over half of these are as a result of cardiovascular disease.

Coronary artery disease is projected to become the leading cause of global morbidity and mortality by 2020. WHO has drawn attention to the fact that CAD is our modern "epidemic". When emerged as the modern epidemic, it was the disease of the higher social classes. Fifty years later the situation is changing, there is a strong inverse relationship between social class and CAD in developed countries.

This trend has grave implications for countries in South Asia. Even with low socioeconomic status, rates of CAD are higher in south Asians and some studies shows that CAD rates in India parallel those in the developed countries. In Indians CAD appears a decade earlier compared with the age incidence in developed countries.

The present mortality rates are the consequences of previous exposure to behavioural risk factors such as inappropriate nutrition, insufficient physical activity and increased tobacco consumption.

Overweight, central obesity, high blood pressure, dyslipidemia, diabetes and low cardiorespiratory fitness are the important contributing factors.

The **metabolic syndrome** refers to a specific clustering of cardio vascular risk factors in the same individual. Persons with this syndrome have a greater risk of death from CAD. So the diagnosis of this syndrome provides early identification of individuals with high risk for CAD and therefore an opportunity to intervene at an earlier stage.

Waist circumference appears to be the most predictive 'screening factor' among the metabolic syndrome criteria. Patient with normal body mass index may still have elevated waist circumference and increased central adiposity.

This study tries to bring out the significance of waist circumference for detecting people with high cardiovascular risk and to determine the optimum level of waist circumference, body mass index and waist hip ratio for diagnosing central obesity in our population.

REVIEW OF LITERATURE

Evolution of cardiometabolic risk factor clustering as a 'syndrome'

The propensity for clustering of metabolic and cardiovascular risk factors in the same individual has been recognised for many years. Perhaps the first description of cardiometabolic risk factor clustering appeared in the medical literature in 1923 when Eskil Kylin (1889 – 1975), a sweedish physician, described a syndrome involving hypertension, hyperglycemia, and hyperuricemia[1]. Sixty five years later in 1998, Reaven described a cluster of risk factors for diabetes and CVD. (hypertension, hyperglycemia, glucose intolerance, elevated triglycerides and low HDL level). He named it as syndrome X' and introduced the concept of insulin resistance. In 1998 WHO proposed the term metabolic syndrome rather than insulin resistance syndrome, since insulin resistance alone could not explain all components of the syndrome. However use of the term 'metabolic syndrome' remained relatively uncommon until 2001 when the National cholesterol education program Adult treatment panel (NCEP ATP III) identified the metabolic syndrome as a risk factor for CVD and as a target for lipid – modifying and other CVD risk reduction therapies.

CORONARY ARTERY DISEASE

Coronary artery disease is the leading cause of death all over the world. CAD rate vary 10 fold among populations. CAD rates among overseas Asian Indians world wide are 50% to 400% higher than people of other ethnic origin irrespective of gender, religion and cast.

India is now in the middle of a CAD epidemic with urban Indians having CAD rates which is 4 fold higher than Americans (Enas Enas et al)[2].

Cardinal features of CAD among Asian Indians:

Asian Indians are prone to develop CAD at a younger age, often before the age of 40 years in men. They are more likely to have an anterior location of infarction and are significantly younger at the time of first hospitalisation for heart failure. CAD in Indians is known to be severe, extensive and malignant despite a lower age and a greater proportion of non smokers.

CAD mortality rates are 2 fold higher in Asian Indian women of 45-64 years of age than in whites[2].

Prevalence of CAD in India:

In India the number of deaths due to CAD was 1.17 million in 1990 and 1.59 million in 2000. It is projected to be 2.03 million by 2010[3].

The prevalence of CAD in urban India is double the rate than in rural India. The rates appear to be higher in south India with Kerala having a prevalence of 13% in urban areas and 7% in rural areas. CAD prevalence is New Delhi is 10% and in Chennai, it is 11% (2) These rates are similar to those among more affluent overseas Indians.

This excess burden of CAD in Asian Indians is due to a genetic susceptibility, mediated through elevated levels of lipoprotein which magnifies the adverse effects of lifestyle factors associated with urbanization, affluence and changes in diet. There is higher rate of abdominal adiposity among urban population, which results in significant dyslipedemia and insulin resistance and a 3 fold increase in diabetes. A more aggressive approach to prevention and treatment of both conventional and emerging risk factors is warranted in Indians.

Risk factors for CAD

Risk factors for CAD can be broadly divided into modifiable and nonmodifiable. The modifiable one can be again divided into lipid and nonlipid factors.

Non modifiable risk factors

1. Age :

   Male > 45 years

   Female > 55 years

2. Family history of premature CAD –

   Male first degree relative < 55 years

   Female first degree relative < 65 years

3. Male Sex:

Modifiable – non lipid risk factors :

1. Hypertension
2. Diabetes
3. Smoking
4. Life style risk factors:

   Obesity - BMI > 30kg/m^2

   Physical inactivity

   Atherogenic diet

Modifiable – Lipid risk factors:

1. Total cholesterol > 200 mg /dL
2. Triglyceride > 150 mg /dL
3. HDL < 40 mg /dL
4. LDL > 100 mg /dL

New emerging risk factors

1. Impaired fasting glucose
2. Homocysteine > 15 μmol/L
3. Subclinical atherogenesis
4. Prothrombotic factors
5. Proinflammatory factors

JAMA 285, 2486 ; 2001.

Coronary risk factors for Asian Indians[4]

Fixed

Male age > 25 years

Female age > 45 years

Family history of premature CAD <55 years

Modifiable non lipid

Hypertension

Cigarette smoking / Tobacco Abuse

DM/ Insulin resistance syndrome

Apple obesity or BMI > 22

Homocysteine > 10μ mol / L

High PAI – 1

Modifiable lipid

TC > 150 mg /dL

TGL > 150 mg /dL

LDL > 100 mg /dL

Apo b > 100 mg /dL

HDL < 40 mg /dL in males and < 50 mg /dL in females

Modifiable lipoprotein ratio

LDL / HDL > 3.5

TC / HDL > 4.5

Apo a / Apo b < 1.2

Lipid Tetrad = Lp(a) x TG x LDL / HDL $\geq$ 20000 mg/dl

[API text book of medicine – 7th edition p – 433]

CAD risk factors can also be classified as **conventional** and **emerging** risk factors. Compared to other ethnic groups, Indians have a lower prevalence of H.T, hypercholesterolemia, obesity and smoking, but a higher prevalence of high triglycerides, low level of HDL, glucose intolerance and central obesity. Although the conventional risk factors do not fully explain the excess burden of CAD, these risk factors appears to be doubly important and remains the principal target for prevention and treatment.

Hypertension

Hypertension is a strong risk factor for CAD. It accelerates the atherosclerotic process especially if Hyperlipedemia is also present. Recent data shows that even high normal levels (SBP 130-139mm of Hg and DBP 85-89mm of Hg) are associated with doubling of CAD risk[5]. Hypertension is closely related with salt intake, alcoholism and obesity.

Generalised obesity

The majority of the patients with CAD are overweight and severity of the disease is more in them. Obesity markedly reduces the life span by about 22% (Kevin P et al[6]). Obesity is associated with increased risk of hypertension, diabetes, dyslipidemia and CAD.

BMI (Body mass index) which is defined as the weight in kilogram divided by height in meter squares is now accepted as an important measure of obesity.

Classification of overweight and obesity by body mass index (Kg/m^2)

Underweight		<18.5
Normal		18.5 – 24.9
Overweight		25.0 – 29.9
Obesity		
Class I	-	30.0 – 34.9
Class II	-	35.0 – 39.9
Class III (Extreme obesity)	-	>40

[API Text Book]

The drawback of BMI is it does not convey information about the distribution of body fat. South Asians have increased abdominal visceral fat and greater insulin resistance at lower levels of BMI, which suggest that reliance on BMI alone may underestimate true risk in our population. Now WHO has revised obesity cut off for Asians from BMI ≥ 30 to BMI ≥ 25[7].

Cut off points of BMI for Asian Indians (Hubbard vs)[8]

Underweight	<18.5
Normal range	18.5 – 22.9
Overweight	≥ 23
At risk	23 – 24.9
Obese I	25 – 29.9
Obese II	≥ 30

Apple type and pear shaped obesity

On the basis of body fat distribution, obesity may be classified into android and gynoid types.

Android obesity is the collection of fat mostly in the abdomen (above the waist). It is also called central obesity and is associated with an increased risk of metabolic complications such as CAD, DM, HT and dyslipidemia. It is the most common acquired cause of insulin resistance. Also known as apple type body.

Gynoid obesity (Pear shaped body) is the collection of fat on the hips and buttock (below the waist or gluteo femoral). This makes the person more prone to mechanical disorders such as varicose vein and disorders of the joint.

Measurement of central obesity

Waist hip ratio (WHR)

The usual measure of central obesity is waist hip ratio. Since the excess fat is usually concentrated in the hip in women and the waist in men, the optimum value for the waist hip ratio is lower in women (<0.85) than in men (<0.95). In Indians the average waist hip ratio in men is 0.93 and in women is 0.84[4].

Waist hip ratio >1.0 in men and >0.9 in women is abnormal (Harrison p.422) and is associated with high morbidity and mortality (Kumar and Clark). Waist hip ratio <0.9 in men and <0.8 in female have a good prognosis[11]. Waist hip ratio >0.88 in females is an independent risk factor for the development of CAD[12].

Waist circumference

Recently waist circumference has been found to be an even better market of central obesity than waist hip ratio. For Asian Indians the optimum waist circumference is <80cm in women and <90cm in men[2]. In men there is increased risk if the waist circumference is 94cm or more and substantial risk if it is 102cm or more[4]. For women the figures are 80 and 88cms respectively.

Diabetes Mellitus

Both diabetes and impaired glucose tolerance are associated with increased cardiovascular risk. A recent study in India showed a prevalence of diabetes and IGT as 12.1% and 15% respectively[14].

Diabetes is associated with central obesity, hypertension, atherogenic dyslipidemia and insulin resistance, all of which have been associated with high CAD risk. Diabetic dyslipidemia consists of elevated triglyceride, low HDL, and an increased proportion of small dense LDL.

Metabolic syndrome

Metabolic syndrome refers to a specific clustering of cardiovascular risk factors (abdominal obesity, atherogenic dyslipidemia, elevated BP, insulin resistance, a prothrombotic state and a pro inflammatory state) in the same individual. It is also known as insulin resistance syndrome, metabolic syndrome, or cardiometabolic syndrome 'X'. The patient with this syndrome are at increased risk for development of diabetes and cardiovascular disease.

Pathogenesis of metabolic syndrome[13]

Central obesity has a key role in the pathogenesis of metabolic syndrome. Visceral adipose tissue (VAT) refers to fat cells located within

the abdominal cavity and includes omental, mesenteric retroperitoneal and perinephric adipose tissue. In lean individuals VAT represents 20% of fat in men and 6% of fat in women. Obese individuals have an expanded fat cell mass characterised by visceral adiposity. The increase in insulin resistance with weight gain is directly related to the amount of VAT.

Normal insulin action

In the fasting state approximately 85% of glucose production is derived from the liver with remainder produced by the kidney. Metabolism of glucose by muscle requires insulin. In the fed state, carbohydrate ingestion leads an increase in plasma glucose concentration and stimulates insulin release from the pancreatic beta cell. The resultant elevation in plasma insulin (1) suppress hepatic glucose production and (2) stimulates glucose uptake by peripheral tissues. The majority of glucose that is taken up by peripheral tissues is disposed in muscle, with only a small amount (4-5%) being metabolised by adipocytes.

Although the fat tissue is responsible for only a small amount of total body glucose disposed, it plays a very important role in the maintenance of total body glucose homeostasis through the release of free fatty acids (FFA). Small increments in plasma insulin exert a potent

antilipolytic effect, leading to a marked reduction in the plasma FFA level. The decline in plasma FFA levels results in increased glucose uptake in muscle and reduces hepatic glucose production.

Visceral fat cells have a high lipolytic rate which is especially refractory to insulin. Increased lipolysis of fat results in elevation of plasma FFAs and cause insulin resistance in muscle and liver and impairs insulin secretion. Obese individuals have increased FFA levels in their blood. FFAs are stored as triglycerides in adipocytes. Obese individuals also have increased stores of triglycerides in muscle and liver and the increased fat content correlates closely with insulin resistance in these tissues. Finally FFA released into the portal circulation drain into the liver where they stimulate production of VLDL particles.

Visceral fat cells are active endocrine cells producing many cytokines including leptin, tumor necrosis factor alpha, interleukin6; plasminogen activator inhibitor -1 (PAI-1) angiotensinogen, resistin and CRP. These adipokines drain into portal circulation and reduce insulin sensitivity in peripheral tissues.

VAT is also the source of anti-inflammatory, antiatherosclerotic adipokines known as adiponectin, a hormone associated with increased

insulin sensitivity. Obesity is associated with decreased levels of adiponectin. Studies have demonstrated abnormalities in adiponectin-insulin sensitivity axis in non diabetic South Asians, which may be an important to atherogenesis, in this population[7]. Raji et al showed lower levels of adiponectin in Asian Indians.

Increased VAT may also leads to elevated level of cortisol, which would increase insulin resistance.

Fat cell size is an important predictor of diabetes. Small newly differentiated adipocytes are more insulin sensitive than large, lipid rich fat cells. The smaller cells are able to take up glucose and store lipid. In contrast, the larger cells have low rates of insulin stimulated glucose uptake, less suppression of lipolysis and a higher rate of cytokine production. Visceral fat cells tend to be larger and more metabolically active than subcutaneous fat cells.

Thus as defined by NCEP-ATP metabolic syndrome primarily is a clustering of metabolic complications of obesity.

Prevalence of metabolic syndrome varies according to the definitions used and the population studied.

Criteria proposed for clinical diagnosis of metabolic syndrome

Clinical measure	WHO (1998)	ATP III (2001)
Insulin resistance	IGT, IFG or lowered insulin sensitivity plus any two of the following	None, but any 3 of the following 5 features
Body weight	Men: WHR >0.90 Women: WHR >0.85 and /or BMI >30kg/m^2	WC ≥102 cm in men or ≥ 88cm in women
Lipid	TG >159 mg/dL and/or HDL-C <35mg/dL in men or <39mg/dL in women	TG>150mg/dL HDL-C <40mg/dL in men or <50mg/dL in women
Blood pressure	>140/90 mmHg	≥130/85 mmHg
Glucose	IGT, IFG or T2DM	>110 mg/dL (includes diabetes)
Other	Microabluminuria	Other features of insulin resistance

The criteria by WHO and ATP III for diagnosing metabolic syndrome may not be appropriate for Asians. IDF (International diabetes federation) had made a first attempt to provide ethnic group specific cut off points for some risk factor such as waist circumference.

IDF criteria for metabolic syndrome

Increased **waist circumference** (population specific) plus any 2 of the following:

- TGL ≥ 150mg/dL or on specific treatment for TGL
- HDL <40mg/dL in men or <50mg/dL in women or on treatment for this lipid abnormality.
- BP ≥ 130 mm of Hg systolic or ≥ 85mm of Hg diastolic or on antihypertensive treatment.
- Fasting plasma glucose ≥ 100mg/dL (includes diabetes).

Ethnic specific values for waist circumference

Country / Ethnic group

Europeans

Men >94 cm

Women >80 cm

South Asian, Chinese

Men >90 cm

Women >80 cm

Japanese

Men >85 cm

Women >90 cm

Subjects with the metabolic syndrome face 2 fold greater risk of all cause mortality and 2-3 fold increased risk of cardiovascular mortality compared with those without the syndrome (Gupta et al). The syndrome is particularly common among Asian Indians.

Love grove JA in his study **"CVD risk in south Asians" the importance of defining adiposity and influence of dietary polyunsaturated fat"**[15] says that south Asians have a higher central obesity and greater CVD risk associated with a lower BMI. Low dietary intakes and tissue level of long chain fatty acid (LC n-3 PUFA) in South Asian population have been linked to high risk abnormalities in the metabolic syndrome. Increasing the dietary intake of LCN-3 PUFA in south Asians has proved as effective strategy for correcting such abnormalities as dyslipidemia in metabolic syndrome.

LIPID ABNORMALITIES OF CAD

Low HDL

HDL is the only known carrier of cholesterol from peripheral tissues to liver i.e. reverse cholesterol transport, which is a protective mechanism against atherogenesis. Each 1mg HDL cholesterol is estimated to decrease CAD evens by 2-4%[16]. HDL >60 is a "negative" coronary risk factor. A low HDL is associated with increased risk of CAD even if TGL and TC levels are not elevated. A 10mg/dL fall in HDL confers the same risk for CAD as 30mg/dL increase in LDL. In general Indians had HDL level 5 mg/dL lower than Europeans and American white[16]. A study on Asian Indians living in the United States found that 54% of men had an HDL level below 40mg/dL and 68% of women had levels below 50mg/dL South Asians not only have lower HDL level but also have a higher concentration of small, less protective HDL particles, which suggests impaired reverse cholesterol transport (2).

High triglyceride

About 95% of triglyceride (TG) in body is stored in adipose tissue as glycerol fatty acids and mono glycerides. An 88mg/dL increase the relative risk of CAD by 30% in men and 75% in women. Paris

prospective study and NCEP ATP[17] III guide line has accepted triglycerides as an important risk factor for CAD. Johnson SL et al1[18]. In STRIDE had noticed higher significance of TG in female CAD. The same was noted by Gupta et al[19] and Acarteik et al[20].

Low TG – high HDL levels have a lower risk of CAD, but this profile is uncommon among Asian Indians.

Total cholesterol

An elevated total cholesterol is a strong risk factor for CAD. Total cholesterol levels and LDL levels are correlated with extent and severity of CAD in Asian Indians as in whites. But at any given total cholesterol or LDL level, Asian Indians a greater CHD risk than white. A recent study has shown an eight fold higher CAD mortality with an increase in TC from 160 to >280mg/dL. Therefore Asian Indians with dyslipidemia should be treated as aggressively as if they had a CHD risk equivalent – similar to the treatment of patients with diabetes or heart disease. The optimum level of total cholesterol appears to be 150mg/dL for Asian Indians.

A TC/HDL of >4.5 has high CAD risk. The ratio <3.5 has been recommended as clinical goal for CAD prevention[27].

LDL cholesterol

Although South Indians have levels of LDL cholesterol comparable to other population, LDL particle size tends to be smaller. Small LDL particles through increased susceptibility to oxidation are more atherogenic than larger particles.

Lipoprotein (a) [Lp(a)]

Lp (a), a variant of LDL is a strong independent risk factor for premature CAD. Lp (a) is often the link between atherosclerosis and thrombosis. It is highly thrombogenic and antifibrinolytic, by virtue of its homology to plasminogen. The term "deadly cholesterol" is used to denote Lp(a). Lp (a) levels are governed by age, gender, diet and other environment factors. Childhood levels of Lp(a) are a better predictor and marker of future CAD in young adult life than any other lipoproteins. Although Lp(a) levels >30mg/dL are generally considered the threshold at which high risk of premature CAD increases rapidly, levels below 15-20mg/dL are considered optimum[2]. Studies of Asian Indians in North America found that 25% to 50% of sampled populations have levels >30mg/dL.

Physical inactivity

Regular physical exercise reduces myocardial oxygen demand and increases exercise capacity. The cardioprotective effects of exercise include decreased adiposity and diabetes incidence, lowered blood pressure and improvement of dyslipidemia, plasma rheology and vascular inflammation. Exercise enhance the insulin sensitivity.

Tobacco abuse

Smoking remains the single most important modifiable risk factor for CAD and the leading preventable cause for CAD. Current smoking of >10 cigarettes or beedi a day is associated with a 6-7 fold increase in the risk of MI. Smoking affect atherothrombosis by several other mechanism. Long term smoking may enhance oxidation of LDL and impairs endothelial dependent coronary artery dilation. Smoking has adverse hemostatic and inflammatory activity including increased level of hs CRP, intercellular adhesion molecule-1 (ICAM-1), fibrinogen, homocysteine and spontaneous platelet aggregation. Smokers have increased prevalence of coronary spasm and may have reduced threshold for ventricular arrhythmia. Asian Indian women have a low rate of smoking. But they may be harmed by passive smoking. The risk of CAD begins to decline

within months of smoking cessation and disappears within 3-5 years. **Socioeconomic status:** CAD has now become a disease of the poor in rich countries and of the rich in poor countries. Asian Indians with a low SES have a higher prevalence of CAD.

Psycho social factors: Depression, hostility and anger and low social support are associated with CAD. Contrary to common belief, type A personality is not associated with an excess of CAD. More than that the prognosis of CAD among type A persons is better than in type B patient.

Emerging cardiac risk factors

The identification of newer methods of risk stratification has been an area of active research. Lipoprotein(a), apo lipoprotein B, homocysteine, plasminogen activator inhibitor-1, pro inflammatory adipokines levels tend to be higher in south asian. These factors support a prothrombotic milieu. Micro albuminuria is recognised as an independent cardiovascular disease risk factor.

Asian Indian paradox

The high rates of CAD in Asian Indians are accompanied by low rates of conventional risk factor except for diabetes. For Asian Indians physical activity was high and saturated fat consumption was low. The

high rate of CAD among Asian Indians despite these enviable levels of risk factors suggest an important role of genetic risk factor.

Prevention of CAD in Asian Indians

It seem appropriate to begin preventive strategies at an earlier age in Asian Indians because of the extreme prevalence and of malignant nature of CAD. Modification of life style, such as increasing physical activity and decreasing consumption of calories particularly saturated fat should begin early in life. Consumption of all types of tobacco products should be eliminated. Clinician should remain aware of the increased prevalence of metabolic syndrome and glucose intolerance in south Asians. Screening methods should include waist circumference rather than WHR and BMI. Assessment of fasting glucose and complete lipid profile are essential. Reduction of abdominal obesity through lifestyle measures can improve all components of the metabolic syndrome and likely delay the development of both diabetes and atherosclerosis. Appropriate drug therapy should be considered for all lipid abnormalities and for the risk factor abnormalities which do not respond to life style modification.

AIM OF THE STUDY

1. To study the significance of waist circumference as an important risk factor for coronary artery disease in females.

2. To study the significance of waist-hip-ratio with coronary artery disease in females.

3. To correlate the association of metabolic syndrome with coronary artery disease in females.

MATERIALS AND METHODS

Setting:

Female patients with acute myocardial infarction admitted to medical ward and intensive coronary care unit of Government Rajaji Hospital, Madurai.

Collaborating departments

Department of Cardiology,

Madurai Medical College,

Madurai.

Department of Biochemistry,

Madurai Medical College,

Madurai.

Design of study : case control study

Period of study: 1 year

Sample size: 80 cases and 24 controls

Selection of subjects

80 female patients admitted with acute myocardial infarction in medicine and cardiology department of Government Rajaji Hospital from 1-7-06 to 31.3.07 formed the study group.

Control group consisted of female attenders of patients who were in the same age group of the cases, without hypertension, diabetes mellitus and coronary artery disease.

Inclusion criteria

Female patients admitted with acute myocardial infarction in medical ward and ICCU were taken.

Exclusion criteria

Secondary causes affecting lipid profile was not taken.

1. Hypothyrodism
2. Nephrotic syndrome
3. Chronic renal failure
4. Connective tissue disorder
5. Patients on hypolipidemic drugs, diuretics, β blockers
6. Patient with previous history of CAD on hypolipidemic drugs
7. Patient with AMI who were not willing to participate in the study

DEFINITION

Acute MI – The criteria for diagnosis of acute MI was done by

1. Definite clinical history
2. Electrocardiographic changes and was supported by echocardiogram

Hypertension - is diagnosed to be present if patients was on anti hypertensive medication or if blood pressure during hospital stay was found to be more than 140mm Hg systolic or 90mmHg diastolic according to JNC VII definition.

Diabetes - Patient was considered to be diabetic if she was diagnosed earlier or was on anti diabetic treatment or on admission, found to have fasting plasma glucose more than 126mg% or postprandial of more than 200mg%.

Obesity - The patient was considered to be obese if her body mass index calculated by wt in kg /Ht in m2 was $\geq$ 25 Kg /m^2.

Waist circumference - Abdominal girth at the level of equidistant between costal margin and illiac crest. ≥ 80cm is taken as abnormal.

Hip circumference - Body girth at the level of greater trochanter is measured.

Waist hip ratio is the ratio calculated by dividing waist circumference by hip circumference. Value $\geq$ 0.85 is taken as abnormal.

Lipid profile Consists of total cholesterol, TG, LDL, HDL and VLDL done by direct enzymatic assay.

Metabolic syndrome was diagnosed according to IDF criteria (MS1) and ATP III criteria (MS2).

Localization of infarction

Site of infarction is localized according to criteria of committee of New York Heart Asso using 12 lead ECG, including V3R and V4R and also using ECHO.

The sites were divided into anterior, anteroseptal, inferior, inferior with right ventricular, inferior with posterior infarction, inferior with posterior and right ventricular extension and lateral wall MI.

Ejection fraction

EF was divided into 3 groups.

> 50% was taken as normal, 40-49% mild, 30-39% moderate, and <30 severe left ventricular dysfunction.

DETAILS OF THE STUDY

80 female patients with proven MI were taken as cases. 24 age matched females without coronary heart disease, HT and diabetes were taken as controls. Detailed history regarding present illness, past illness, treatment history and personal history was taken. Clinical examination including blood pressure monitoring and anthropometric measurements was done. Fasting and post prandial blood sugar, lipid profile, blood urea, s.creatinine, ECG and Echo were done both for cases and controls. By history, clinical examination and biochemical analysis, secondary causes of elevated lipid profile was excluded. The collected datas were analysed for correlation with coronary artery disease.

Ethical approval : Obtained

Consent : Informed consent was obtained

Financial support : Nil

Conflict of interest : Nil

STATISTICAL ANALYSIS

The information collected regarding all the selected cases were recorded in a master chart. Data analysis was done with the help of computer using Epidemiological information package (EPI 2002). Using this software, frequencies, percentages, mean, standard deviation, α 2 and 'p' values are calculated. A 'p' value less than 0.05 is taken to denote significant relationship.

A. Characteristics of Cases and controls

Table 1

Age Distribution

Age in years	Study Group		Control Group	
	No.	%	No.	%
Less than 40	-	-	-	-
40-49	12	15	7	29.2
50-59	38	47.5	11	45.8
60-69	25	31.3	6	25
70 & above	5	6.2	-	-
Total	80	100	24	100
Mean S.D.	56.6 yrs 7.7 yrs		53.7 yrs 7.2 yrs	
P	0.2041 (Not significant)			

Mean age in study were 56.6 with S.D 7.7 years. Control group mean age was 53.7 with S.D of 7.2 yrs. P value 0.2041 The difference was statistically not significant ie the two groups were comparable.

Table 2

Other Demographic Characteristics

Characteristics	Study Cases		Control cases		'p'
	No.	%	No.	%	
Domicile					
a) Urban	32	40	10	41.7	0.9273
b) Rural	48	60	14	58.3	(Not significant)
Employed					
a) Yes	12	15	6	25	0.2005
b) No	68	85	18	75	(Not Significant)
Socio Economic Status					
a) High	18	22.5	6	25	0.983
b) Low	62	77.5	18	75	(Not significant)
Life Style					
a) Sedentary	54	67.5	18	75	0.6555
b) Not Sedentary	26	32.5	6	25	(Not Significant)
Diet					
a) Vegetarian	-	-	-	-	-
b) Non vegetarian	80	100	24	100	
Tobacco smoking					
a) Present	-	-	-	-	-
b) Absent	80	100	24	100	
Personality Type					
A	19	23.8	2	8.3	0.0812
B	61	76.3	22	91.7	(Not Significant)
Menstrual Status					
a) Premenopausal	9	11.3	3	12.5	0.5568
b) Post Menopausal	71	88.8	21	87.5	(Not Significant)

Other demographic parameters like domicile, employment status, socioeconomic status, life style, diet, tobacco smoking, personality type and menstrual status of the cases and controls compared. The difference between the groups were not statistically significant.

Table 3

Risk Factors

Risk Factors	Study Cases		Control cases		'p'
	No.	%	No.	%	
HT					
a) Present	41	51.3	-	-	**0.0002**
b) Absent	39	48.8	24	100	**(Significant)**
DM					
a) Present	28	35	-	-	**0.0018**
b) Absent	52	65	24	100	**(Significant)**
CVA					
a) Present	-	-	-	-	-
b) Absent	80	100	24	100	
OCP use					
a) Present	1	1.3	-	-	0.7692
b) Absent	79	98.2	24	100	(Not Significant)
Family History					
a) Present	15	18.8	4	16.7	0.5416
b) Absent	65	81.3	20	83.3	(Not significant)

The risk factors for CAD like hypertension, diabetes, cerebrovascular accidents, OCP use and a family history of the two groups were compared.

There was no significant difference between these two groups except for hypertension and diabetes (we have taken controls without hypertension and diabetes).

Incidence of H.T among cases were 51.3%. Incidence of D.M among cases were 35.0%. Incidence of CVA among cases and control were zero.

Only one case had history of OCP use, with none in the control group. Family history of CAD was present in 18.8% of cases and 16.7% of control. The difference was not statistically significant.

Anthropometric measurement

Table 4

Height, Weight, and BMI

Parameters	Study Cases		Control cases		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
Height (in cms)	147.8	5.7	149.3	7.1	0.1835 (Not significant)
Weight (in kg)	55.2	9.3	46.5	6.8	**0.0001 (Significant)**
BMI	25.3	4.1	20.7	2.6	**0.0001 (Significant)**

Height - Mean height in the study groups was 147.8cm with S.D of 5.7 cm. Mean height in the control groups was 149.3 cm with a S.D of 7.1 cm. The p value was 0.1835 which was statistically not significant.

Weight (in kg) - Mean weight of the study group was 55.2 with S.D of 9.3 kg. Mean weight of the control group was 46.5 kg with of S.D of 6.8kg. The difference was statistically significant. P value 0.0001. This shows the significance of over weight as a risk for CAD.

BMI - Mean BMI of the study group was 25.3 with a S.D of 4.1 The mean BMI of control group was 20.7 with a S.D of 2.6. P value 0.0001. The difference was statistically significant, showing the significance of obesity as an important risk factor for CAD.

Table – 5

Waist circumference and WHR

Parameters	Study Cases		Control cases		'p'
	Mean	S.D.	Mean	S.D.	
Waist Circumference in cms	87.5	9.7	77.5	5	**0.0001 (Significant)**
Hip Circumference in cm	90.8	7.5	83.8	5.1	**0.0001 (Significant)**
W/H Ratio	0.96	0.07	0.92	0.03	**0.0001 (Significant)**

Waist circumference

The mean waist circumference (W.C) in study group was 87.5 with a S.D of 9.7 and the W.C of control group was 77.5 with a S.D of 5. P value 0.0001. The difference was statistically significant, showing that central obesity is an important risk factor for CAD.

W.H.R

The mean W.H.R in the study group was 0.96 with S.D of 0.07. The mean W.H.R of control group was 0.92 with S.D of 0.03. P value 0.0001. The difference was statistically significant. This again shows the significance of central obesity as an important risk factor for CAD.

Table – 6

Lipid profile

Parameters	Study Cases		Control cases		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
TC	186.3	50.4	162.5	34.4	**0.0473 (Significant)**
TGL	179.3	61.8	140.8	53.2	**0.0025 (Significant)**
HDL	42.6	4.8	44.1	4.0	0.2096 (Not significant)
LDL	105.3	46.9	78.8	31.8	**0.0089 (Significant)**
TC/HDL	4.38	1.37	3.66	0.82	**0.0303 (Significant)**

TC

The mean total cholesterol in the study group was 186.3 with a S.D of 50.4. The mean total cholesterol in the control group was 162.5 with a S.D of 34.4. P value 0.0473. The difference was statistically significant showing that high total cholesterol is an important risk factor for CAD.

TGL

The mean TGL (triglyceride) in the study group was 179.3 with S.D of 61.8. The mean TGL of control group was 140.8 with a S.D of 53.2. P value 0.0025.

The difference was statistically significant and shows that high TGL is an important risk factor for CAD.

HDL

The mean HDL in the study group was 42.6 with S.D of 4.8. The mean HDL of the control group was 44.1 with a S.D of 4.0 HDL level has an **inverse** relation with CAD risk. HDL was low in the study group compared to control. But the difference was statistically not significant (P value 0.2096).

LDL

The mean LDL of the study group was 105.3 with a S.D of 46.9

The mean LDL of the control group was 78.8 with S.D of 31.8. P value 0.0089. The difference was statistically significant showing that high LDL is an important risk factor for CAD.

TC/HDL

Mean TC/HDL ratio in the study group was 4.38 with S.D of 1.37, mean TC/HDL of control group was 3.66 with a S.D of 0.32. The difference was statistically significant showing that a high TC/HDL is an important risk factor for CAD.

Table 7

Metabolic Syndrome (MS_1- by IDF criteria)

MS1	Study Group		Control Group	
	No.	**%**	**No.**	**%**
Present	57	**71.2**	6	**25**
Absent	23	28.8	18	75
'p'	**0.0001 (Significant)**			

Metabolic syndrome by IDF criteria (MS_1)

The percentage of M.S in the study group was 71.2%. The percentage of M.S in the control group of 25%. P value 0.0001 The difference was statistically significant showing the significance of metabolic syndrome as an important coronary risk factor.

Table 8

Metabolic Syndrome (MS2 – by ATP III Criteria)

MS2	Study Group		Control Group	
	No.	**%**	**No.**	**%**
Present	53	**66.3**	3	**12.5**
Absent	27	33.7	21	87.5
'p'	**0.0001 (Significant)**			

Metabolic syndrome by ATP III criteria (MS2)

In the study group percentage of metabolic syndrome was 66.3% and in the control group 12.5%. P value 0.0001. The difference was statistically significant.

By using IDF criteria, more number of metabolic syndrome were identified. So for the defection of metabolic syndrome in our population IDF criteria is a better option.

B. Abnormalities in the two groups

Table 9

Comparison of waist circumference between cases and controls

Waist Circumference	Study Group		Control Group	
	No.	**%**	**No.**	**%**
Classification I with 80 cms as cut off				
a) Normal (< 80 cms)	12	15	14	58.3
b) Abnormal (≥ 80 cms)	68	**85**	10	41.7
'p'	**0.0001 (Significant)**			
Classification II with 88 cms as cut off				
a) Normal (< 88 cms)	37	46.3	24	100
b) Abnormal (≥ 88 cms)	43	**53.8**	-	-
'p'	**0.0001 (Significant)**			

Classification I – with 80 cm as cut off value. There was 85% of cases with waste circumference ≥ 80 cm in the study group. There was 41.7% of control group had waist circumference ≥ 80cm. P value 0.0001. The difference was statistically significant.

Classification II – with 88 cms as cut off, percentage of study group with ≥ 88cm waist circumference was 53.8%. percentages of control with ≥ 88 cm waist circumference was zero. P value 0.0001.

The difference was statistically significant.

By using waist circumference cut off value as 80 cm instead of 88 cm, we can defect more number of cases with increased risk for coronary artery disease. So for screening of our population, it is better to use waist circumference cut off value ≥ 80cm as abnormal.

Table 10 - A

Waist hip Ratio

Waist Hip Ratio	Study Group		Control Group	
	No.	**%**	**No.**	**%**
Normal (< 0.85)	7	8.8	-	-
Abnormal **(≥ 0.85)**	73	**91.3**	**24**	**100**
'p'	0.1495 (Not Significant)			

Waist hip ratio (WHR)

Percentage of study group with WHR ≥ 0.85 was 91.3%. percentage control group with WHR ≥ 0.85 was 100%. P value 0.1495.

The difference was not statistically significant i.e, it is better not to use WHR cut off value at ≥ 0.85 as abnormal in our population.

Table 10 - B

WHR with different cut off levels

In this, we categorised the cases and control with 4 different groups as cut off value of WHR as 0.8; 0.84, 0.88 and 0.92. The difference between the two groups was statistically significant only when WHR cut off was kept at 0.92. This shows that for our population, we have to keep

the WHR at a higher level. So waist circumference ≥ 80 cm is a better criteria to detect females with CAD, than WHR ≥ 0.85.

Table – 10 B

Waist Hip Ratio

Waist Hip Ratio	Study Group		Control Group	
	No.	%	No.	%
Group I with 0.8 as cut off				
Normal (< 0.8)	2	2.5	-	-
Abnormal (≥0.8)	78	97.5	24	100
'p'	0.59 (Not Significant)			
Group II with 0.84 as cut off				
Normal (< 0.84)	7	8.8	-	-
Abnormal (≥0.84)	73	91.3	24	100
'p'	0.1495 (Not significant)			
Group III with 0.88 as cut off				
Normal (< 0.88)	9	11.3	2	8.3
Abnormal (≥0.88)	71	88.8	22	91.7
'p'	0.5111 (Not Significant)			
Group IV with 0.92 as cut off				
Normal (< 0.92)	11	13.8	11	45.8
Abnormal (≥0.92)	69	86.3	13	54.2
'p'	**0.002 (Significant)**			

Table – 11

BMI

BMI	Study Group		Control Group	
	No.	**%**	**No.**	**%**
Classification I with 25 as cut off				
a) Normal (< 25)	39	48.8	23	95.8
b) Abnormal **(≥ 25)**	41	**51.3**	1	4.2
'p'	**0.0001 (Significant)**			
Classification II with 23 as cut off				
a) Normal (< 23)	22	27.5	21	83.3
b) Abnormal (≥ 23)	58	**72.5**	4	27.7
'p'	**0.0056 (Significant)**			

Classification 1 with 25 as cut off

Percentage of study group with BMI ≥ 25 was 51.3%. Percentage of control group with BMI > 25 was 4.2%. P value 0.0001. The difference was statistically significant.

Classification II with 23 as cut off

Percentage of study group with BMI > 23 was 72.5%. Percentage of control group with BMI > 23 was 27.3. P value 0.0056. The difference was statistically significant.

The shows that, by using the BMI of value ≥ 23 as abnormal instead of ≥ 25, the more number of cases was detected (72.5% vs 51.3%).

Table – 12

Waist circumference and BMI

BMI	Waist circumference			
	<80 cm		>80 cm	
	No	%	No	%
BMI≥25 (41)	Zero	Zero	41	**100%**
BMI < 25	12	30.8%	27	**69.2%**
P value 0.0004. significant				

On comparing waist circumference and BMI, in our study 41 out of 80 cases had BMI > 25. All the cases (100%) with BMI ≥25 had waist circumference ≥80 cm. Off the 39 patients with BMI <25 , only 69.2% had waist circumference > 80cm the P value is 0.0004. (significant) this shows that there is a significant association between waist circumference >80cm and BMI > 25.

Table 13-A

WAIST CIRCUMFERENCE AND H.T

	Waist circumference			
Total No of HT (41)	**< 80cm**		**>80cm**	
	No	%	No	%
	5	**12.2%**	36	**87.8**

41 cases of the study group had HT. Off these 87.8% had waist circumference > 80 cm.

Table 13-B

WAIST CIRCUMFERENCE AND DIABETES

Total No of D.M.(28)	**Waist circumference**			
	< 80cm		**>80cm**	
	No	%	No	%
	2	**7.1%**	26	**92.8%**

28 cases of the study group were diabetic. 92.9% of them had waist circumference > 80cm.

Tables 13A and 13B, Shows that waist circumference $\geq$ 80cm is significantly associated with H.T. and diabetes.

Table – 14

Waist circumference and lipid profile

Lipid profile	Waist circumference					
	<80cm		>80cm		P value	Interpretation
	Mean	S.D.	Mean	S.D.		
TC	157.6	37.6	188.5	48.9	0.00048	**Significant**
LDL	78.0	29.9	106.3	47.3	0.00075	**Significant**
HDL	43.7	4.5	42.7	4.6	0.5915	Not Significant
TC/HDL	3.66	0.95	4.4	1.35	0.0093	**Significant**
TGL	136.8	46.2	181.6	62.6	0.0007	**Significant**

There is a significant difference between mean value of **TC, TGL, LDL,** and **TC/HDL** of patients with waist circumference > 80cm compared to that of waist circumference <80cm. This shows that waist circumference >80cm is associated dyslipidemia.

Table – 15

Waist circumference and metabolic syndrome

Risk Factors	Waist circumference			
	<80cm		>80cm	
	No.	%	No.	%
MS1				
Present (57)	-	-	57	**100**
Absent (23)	12	52.2	11	**47.8**
'p'	**0.0001 (Significant)**			

57 patients of our study group had metabolic syndrome by IDF criteria. 100% of them had waist circumference > 80cm. 23 patients of the study group were not having metabolic syndrome. Only 47.8% of them had waste circumference > 80cm. The difference was statistically significant that means, as waist circumference is increases there is increased chance of having metabolic syndrome and thus increased chance for cardiovascular risk factors.

Table – 16

ECG and Echo

ECG Findings	Study Group		Control Group	
	No.	%	No.	%
AL	2	2.5	-	-
AS	4	5	-	-
AW	37	46.25	-	-
AW & LW	2	2.5	-	-
AW & AS	3	3.75	-	-
AW & L	3	3.75	-	-
IW	27	33.75	-	-
IW & PW	1	1.25	-	-
IW & L	1	1.25	-	-
Normal	Nil	-	24	100

The maximum Number of infarction was anterior wall MI. Next was inferior MI.

Table - 17

Ejection Fraction %

Parameters	Study Cases		Control cases		'p'
	Mean	S.D.	Mean	S.D.	
EF%	42.8	9.4	58.8	4	**0.0001 (Significant)**

Mean ejection fraction of the study group was 42.8% and that of control was 58.8%. The difference was statistically significant.

EF%	Study Group		Control Group	
	No.	%	No.	%
Normal (≥50)	14	17.5	24	100
Abnormal (<50)	66	82.5	-	-
'p'	**0.0001 (Significant)**			

100% of Control group had EF >50% only 17.5% of cases had EF>50% p value 0.0001. The difference was statistically significant.

DISCUSSION AND COMPARATIVE ANALYSIS

In my study there were 80 female patients with acute myocardial infarction and 24 female controls of the same age group without coronary artery disease, hypertension and diabetes.

Anthropometric results

Waist circumference

Mean waist circumference of our study group was 87.5cm and control group was 77.5cm.

For Asian Indians the optimum waist circumference is <80cm in women and <90cm in men[23].

Waist circumference well correlate with abdominal fat content. In men there is increased risk if waist circumference is 94cm or more and substantial risk if it is 102cm or more. For women the figures are 80cm and 88 cm respectively (API-text book, 7th edn. p.265).

Patients with abnormal waist circumference irrespective of age, sex and BMI have high risk for developing CAD. This observation is supported by the following studies. Study by Sonmezk, Akcakoyun M, Akcay A et al **which method should be used to determine the obesity,**

in patients with coronary artery disease. Int. J. Obes. Relat. Metab. Diserd.2003;[24].

In this study of total 617 cases with age 57.2 ± 10.8 with angiographically established coronary artery disease were studied. BMI, waist circumference WHR were compared as a whole and also within stratified groups of sex and age and compared with other risk factors. In that study the percentage of female cases with obesity with respect to BMI was 32%. Percentage of females with action level II waist circumference were 71% and percentage of female with WHR ≥0.85 was 86%.

In our study the mean age group was 56.6 ± 7.7 and is comparable. The corresponding percentages in our study was 51.3% (BMI), 85% (waist circumference) and 86% (WHR). These percentages are comparable except for that detected by BMI. This variation could be due to the difference of population and ethnicity.

Sonmez concludes the study stating that in the same study group, percentage of obesity differ significantly in terms of BMI, waist circumference and WHR. The utilisation of BMI alone for detection of obesity in CAD patients may not be sufficient for precise assessment.

Therefore in cases with CAD, waist circumference can be the method of choice for the assessment of obesity more accurately.

Study by TS Hans, Em Van Leer. JC seizleer MEJ Lean "**Waist circumference action levels in the identification of cardiovascular risk factors**[25].

The objective of the study was to determine the frequency of cardiovascular risk factors in people categorised by previously defined "action levels of waist circumference".

In that study 2183 men and 2698 women aged 20-59 years were selected, waist circumference, WHR, BMI, total plasma cholesterol, HDL level, blood pressure, age and life style was studied.

Result was a waist circumference 94 cm in men and 80cm in women correctly identified subjects with BMI ≥25 and WHR ≥0.95 in men and ≥0.80 in women with a specificity of 96%.

In our study all patient with BMI >25 had waist circumference >80 cm with a specificity of 100%. So the level of waist circumference >80cm is very significant in our population for detection of females with increased CAD risk.

The author gives the message that compared with people with waist circumference below action level 1 (94 cm in men and 80 cm in women), those with waist circumference between action level 1 and 2 (94 to 101 cm in men and 80-87 cm in women) are one and a half to two times likely to have one or more major CAD risk factor. A waist circumference above action level 1 should be a signal to avoid weight gain, to maintain increased physical activity and to give up smoking.

People with waist circumference above action level 2 are two and a half to four and a half times likely to have one or more major cardiovascular risk factors. So the patients with a waist circumference above action level 2 should seek advise from health professional for weight management.

Cikim AS, Ozbey N, Orhan Y. Study **"Relationship between cardiovascualr risk factors and types of obesity in overweight and obese women"** J Int Med. Res. 2004 May-Jun[26].

In this study they aimed to evaluate the relationship between types of obesity and cardiovascular risk factors.

A total of 623 overweight (BMI >25 kg/m^2) and 2559 obese (BMI >30kg/m2) women were divided into 4 groups according to their BMI and WHR.

1. Simple over weight (BMI 25-30; WHR <0.8)

2. Abdominal adiposity (BMI 25-30; WHR >0.8)

3. Peripheral obesity (BMI 25-30; WHR <0.8)

4. Central obesity (BMI >30; WHR >0.8)

They found that risk indicators measured were significantly higher in the central obesity group. Total body fat and abdominal fat accumulation seems to result in more serious insulin resistance in central obesity.

Mergaret ashwell and colligues in the study " **Waist circumference remains useful predictor of coronary heart disease"** BMJ 1996 say that height does not have an important role in explaining variations in the waist circumference. Simplicity of using the waist circumference argue against waist to height ratio particularly in a public health programe.

Balkau B, Sapinho D, Petrella et al. in the study **" Prescreening tools for diabetes and obesity associated dyslipidemia; comparing**

BMI; Waist circumference and waist hip ratio" Eur.J. Clin. Nutr. 2006 Mar.

The objective of the study was to compare the sensitivity of BMI, Waist circumference and WHR in identifying subjects 'who should be screened for diabetes and or for obesity associated dyslipidemia'. The result of the study was for women, waist circumference had a higher sensitivity than BMI or WHR for detecting diabetes. For detecting dyslipidemia, Waist circumference and WHR had similar sensitivities, higher than for BMI.

Waist to Hip Ratio:

The mean WHR of our study group was 0.96. and of the control group was 0.92. Compared to control group, there was a significantly high WHR in the study group, which again stress the importance of central obesity as a risk factor for CAD. In Harrison[9] it is given that WHR > 0.9 in women is abnormal.

In our study the cut off value for WHR was kept $\geq$ 0.85 as abnormal as per the optimum value for Asian Indians.[2] and[29] WHR $\geq$ 0.85 as cut off value was not statistically significant in our study.

So for our population for detecting females with high CAD risk, waist circumference $\geq$ 80 cm as abnormal will be a better criteria than WHR $\geq$ 0.85.

In the text book of Braunwald's heart disease (P.1954) says that, among women waist hip ratio greater than 0.88 is a predictor of substantially increased risk of cardiovascular events.

Arlette Cparry, Paul C Miller et al in the study[30] **"Clinical predictability of the waist to hip ratio in assessment of cardiovascular disease risk factor in overweight premenopausal women,** Am J.Clinical nutr 1998; states that although the American heart association has reported that a WHR > 0.80 be used to indicate increased risk of cardiovascular disease in women, the present study assessed the WHR above which is seen elevations in cardiovascular disease risk factors in a sample of overweight women, using data from 240 women aged 27.5-47.5. They determined WHR quartiles: < 0.80, .80 to <0.84, 0.84 - <0.90 and > 0.90. Subjects were placed into high risk categories for cardiovascular disease on the basis of age and population defined norms. Women had an increased likelihood of elevated VLDL, triglyceride, low HDL, diastolic blood pressure and composite risk (ie having $\geq$ 4 CAD risk

factors) at a WHR $\geq$ 0.90. All afore mentioned variables had a significant odds ratio at WHR $\geq$ 0.90. They concluded that "these data suggest an upward shift in the critical threshold for WHR to $\geq$ 0.90 , at which point there was an elevation in cardiovascular disease risk factors, in over weight females.

Body Mass Index

Mean BMI of our study group was 25.3 and that of control group was 20.7 According to BMI values for Asian Indians[31], mean BMI of our study group belongs to obesity class 1 and that of control belongs to normal range. For Asians the optimum BMI is <23, where as 23-25 is considered as overweight and ≥25 obese[2]. In our study when we kept the cut off BMI $\geq$ 23 as abnormal the difference between cases and control was significant statistically, and the percentage of abnormally detected was increased from 51.3 % to 72.5% . So for better detection of females with increased CAD risk, it will be better to use BMI $\geq$ 23 as normal instead of $\geq$ 25. The Framingham offspring study demonstrated a dramatic rise in risk factors for cardiovascular disease at BMI above 20[32].

Lipid profile Analysis

Lipid profile analysis of our study showed that the mean total cholesterol, TG, LDL and TC/HDL ratio were significantly high in the study group compared to the control group. This shows the association of dyslipidemia as an important risk factor for CAD.

On comparing our study with the study by Binu et al[37], The mean total cholesterol in our study was 186 mg/ dl and their study was 214 mg/dl. Similarly the mean LDL in our study was 105 mg/dl and their study was 147. The mean TG in our study was 179.8 and in that study was 152. On comparing these two study, we see that TG abnormality is high in our study where as total cholesterol and LDL abnormality high in Binu et al study.

This difference may be because our study group had only female cases, where as in that study had both males and females with males number predominating. This shows the significance of increased TG as an important risk factor for CAD in females[19,20] Gupta et al, Acartek et al.

Now comparing the lipid profile and waist circumference, in our study , there is a significant association between waist circumference > 80 cm and ellivated levels of TC, TG, LDL, and TC/HDL ratio. This

significance was maximum for the association of TG. This is supported by study[28] and[37].

M.G.F.Lemos – Santos. MPH, et al study. **"Waist circumference and waist to – hip ratio as predictors of serum concentrations of lipids in Brazilian men."** Nutrition Oct 2004 (37) in their study multiple linear regression analysis was performed to quantity the association between fat distribution (WC and WHR) and the TC/HDL ratio and TG. In their study, waist circumference was strongly correlated with percentage of body fat (r=0.90) where as WHR correlated less (r=0.55) and they concluded waist circumference as a good predictor of lipid profile.

Our study shows that waist circumference > 80cm is a warning to screen for dyslipidemia in females.

Comparing the HDL among the cases and controls, though low HDL was more in the study group than the control, the difference was not significant. While comparing HDL and WC a low HDL was found in the study group with WC >80cm, though the difference was not statistically significant. A low HDL is very common among Indians and genetic factor may be involved as the cause (Enas A Enas)[34]. Asians not only have lower

HDL level but also have a higher concentration of small, less protective HDL particles which suggests impaired reverse cholesterol transport (Milan Gupta et al).

Metabolic Syndrome

In our study using IDF criteria 71.2% our cases had metabolic syndrome. Using ATP III criteria 66.3% had metabolic syndrome this shows that there is a significant association between metabolic syndrome and coronary artery disease.

Gupta et al[7] says that metabolic syndrome face a 2 fold greater risk of all cause mortality and 2-3 fold increased risk of cardiovascular mortality compared to those without this syndrome.

Solymoss BC, Bourass MG, Lesporance J.et al. in the study **"Incidence and clinical characteristics of the metabolic syndrome in patients with coronary artery disease"** Coronary artery disease 2003;[38] in a Canadian population with CAD (793 men 315 women of age 58.1 $\pm$9.8 years) noted that metabolic syndrome patients had significantly higher waist circumference, blood pressure levels and low level of HDL levels. In their study 51% of participants had metabolic syndrome (using NCEP, ATP III Criteria)

In our study using ATP III criteria the percentage of MS was 66.3% showing a high prevalence of metabolic syndrome in our population.

In our study we could detect more cases of MS by IDF criteria than by ATP III criteria Chee – Eng Tan, Stefan MG, Doniel wan et al – in the study **"Can we apply the NCEP – ATP III Definition of the metabolic syndrome to Asians?"**[39] diabetes care 2004, says that decreasing waist circumference cut of value from 88cm to 80 cm increased the crude prevalence of metabolic syndrome from 12.2 to 17.9%. Using modified Asian criteria the prevalence of metabolic syndrome increased 31.0% in those aged 60-69 years.

Their conclusion is NCEP – ATP III criteria applied to Asian population will under estimate the population at risk. With a lower waist circumference cut off, the prevalence of metabolic syndrome is comparable to that in western populations. Ethnic differences are likely to exist between populations across Asia.

Milan Gupta et al says when ATP III criteria and modified waist circumference cut off were used, the metabolic syndrome was present in 41.1% of urban Indian adults and in 27.9% of subjects with normal

plasma glucose. Our study result is comparable to this. In our study 25% of the control (with normal plasma glucose) had metabolic syndrome.

Deepa M; Farooq S, Datta S, et al in study **"Prevalence of metabolic syndrome using WHO , ATP III and IDF Definitions in Asian Indians; the Chennai urban Rural Epidemology study (CURES -34)**[40] Feb – 2007.

This is one of the largest epidemiological study on diabetes carried out in India. In which 26000, individuals >20 years were screened for metabolic syndrome. Metabolic syndrome was identified in 23.2 % cases by WHO criteria, 18.3% by ATP III criteria and 25.8 by IDF criteria. There was an increased risk of probable CAD in metabolic syndrome subjects diagnosed by WHO criteria. They concludes that in Asian Indians, the WHO, ATP III and IDF criteria identify MS differently.

DECODA study group[41] in the study **"Prevalence of metabolic syndrome in populations of Asian origin, comparison of the IDF definition with the NCEP definition,"** they found that the IDF brought out a higher prevalence of the MS than NCEP in all groups (Chinese, Mauritian Indians and native Indians) except for Japanese women.

SUMMARY

The study **"Waist circumference as a significant risk factor for coronary artery disease in females''** was a case control study with 80 female patients admitted with acute myocardial infarction, in Govt. Rajaji hospital, Madurai. Controls were devoid of hypertension, diabetes and coronary artery disease.

Patients and controls who satisfied the inclusion criteria underwent various investigations like blood sugar, urea, creatinine, lipid profile, ECG & echocardiogram. Relationship of various anthropometric measurements like waist circumference, waist hip ratio and body mass index with the risk factors of coronary artery disease were analyzed. A high waist circumference had an important correlation with hypertension, diabetes, dyslipidemia and metabolic syndrome. Females with coronary artery disease were detected to have a high prevalence of metabolic syndrome.

Thus our study highlights the significance of a simple measurement of waist circumference in day to-day clinical practice in detecting the patients with high cardiovascular risk like hypertension, diabetes, obesity, dyslipidemia and metabolic syndrome. The cut off values for waist

circumference, waist hip ratio and BMI should be defined according to the different ethnic populations. This will help in early detection of the people at risk so that we can advice healthy life style and nutritional habits for the high risk group and start specific therapy when ever necessary.

CONCLUSION

The following conclusions are derived from our study.

1. Waist circumference ≥80cm is an important risk factor for coronary artery disease in females.
2. In females, cut off value of waist circumference ≥80cm (instead of ≥88cm) is more sensitive in detecting coronary artery disease risk factors.
3. Waist Circumference ≥80cm is a better parameter than WHR≥ 0.85 for detection of coronary artery disease risk factors in females.
4. In females cut off value of BMI as ≥23kg/m2 instead of ≥25kg/m2 is more sensitive in detecting coronary artery disease risk factors.
5. Waist circumference >80cm has significant correlation with elevated triglycerides, total cholesterol, LDL, and TC/HDL ratio (maximum correlation with increased triglyceride).
6. Waist circumference >80cm has a significant correlation with hypertension, diabetes, obesity and metabolic syndrome.
7. There is a significantly high prevalence of metabolic syndrome among the females with Coronary artery disease.

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PROFORMA

WAIST CIRCUMFERENCE

AS A SIGNIFICANT CORONARY RISK FACTORS FOR FEMALES

1.	Sl.No	:	
2.	Name	:	
3.	IP/OP No	:	
4.	Age	:	
5.	Domicile	:	Urban /Rural
6.	Employed	:	Yes / No
7.	Life Style	:	Sedentary / Non Sedentary
8.	Diet	:	Vegetarian / Non Veg.
9.	Addiction	:	Tobacco abuse / Any others
10.	Personality type	:	Type A / Type B
11.	Menstrual Status	:	Pre menopausal / Post menopausal
12.	Admitted for C/o	:	Chest pain / Dyspnea / Giddiness / Pedal edema / Palpitation / Others
13.	Past History	:	HT / DM / CVA / CAD / Others
14.	Drug History	:	OCP / Steroids / Beta blocker / Frusemide / Others.

15. Family H/o CAD : Yes / No

16. Examination : Anthropometry

Height (in cm)	Weight (in kgs)	BMI Kg/m2	Waist (in cm) Circumference	Hip (in cm) Circumference	W/H Ratio

G.E. : Pallor /Edema /Cyanosis / Jaundice /Clubbing

CVS : PR : BP : JVP:

S1 S2 S3 S4

RS :

Abdomen :

17. Investigation :

FBS	PPBS	Bl.Urea	S.Creatinine	Hb

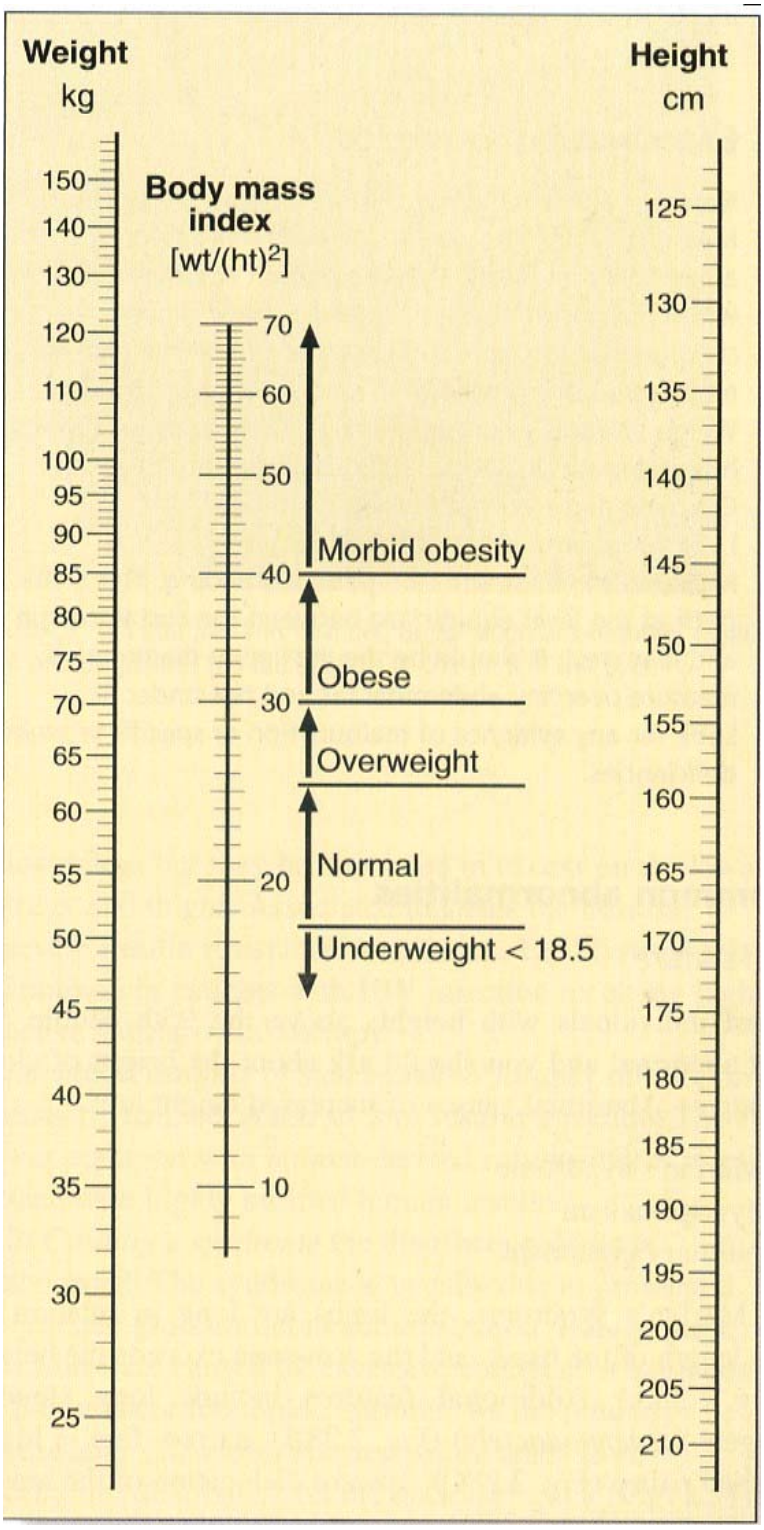
Lipid Profile :

Total cholesterol	T.G.	HDL	VLDL	LDL

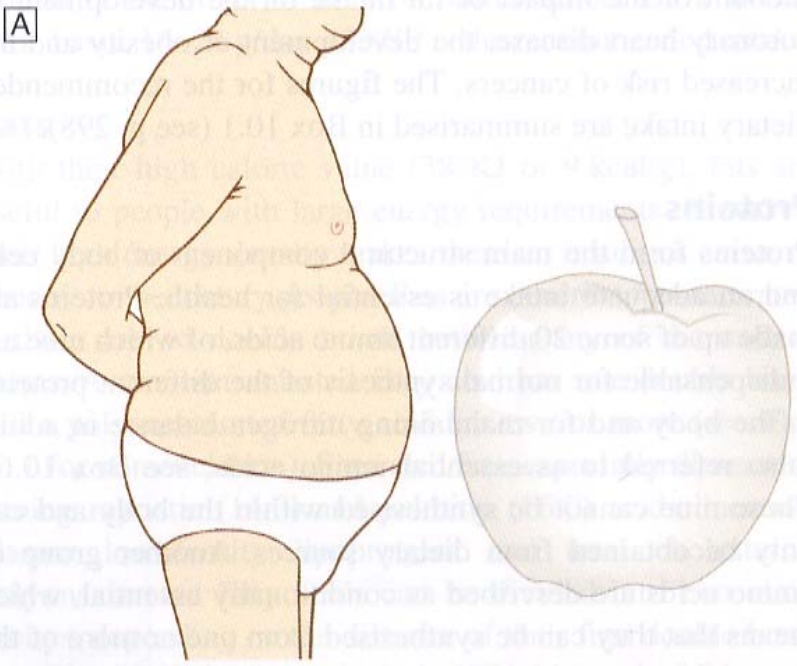
ECG :

ECHO :

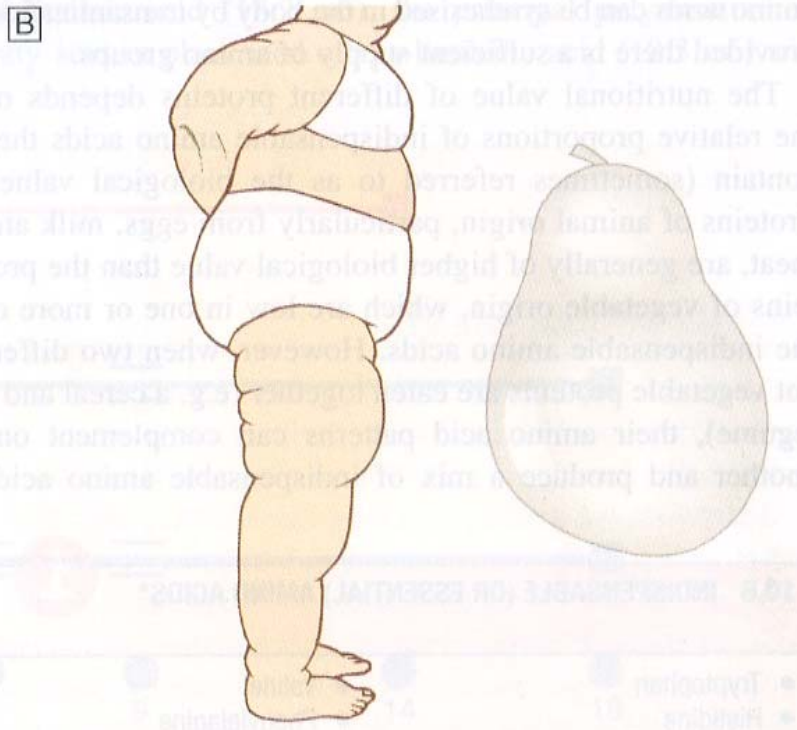
DESIRABLE WEIGHTS OF ADULTS ACCORDING TO BODY MASSS INDEX



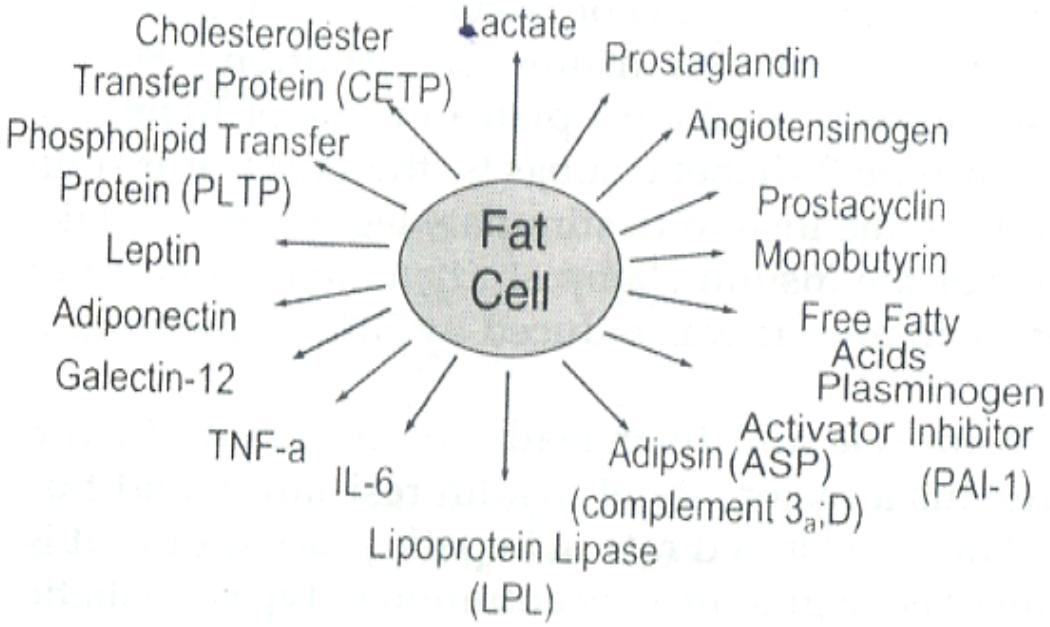
A- ABDOMINAL OBESITY (APPLE SHAPE)



B- GENERALISED OBESITY (PEAR SHAPE)



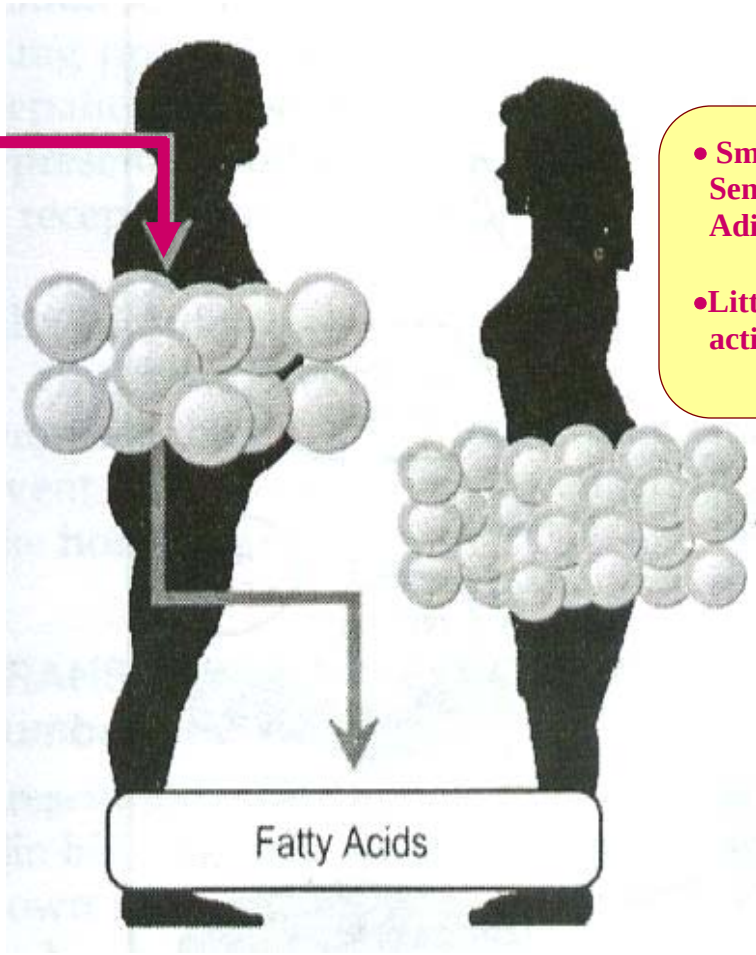
ADIPOCYTOKINES



OVERPRODUCTION OF ADIPOSE TISSUE DERIVED PROTEOHORMONES IN OBESITY PROMOTES THE DEVELOPMENT OF METABOLIC SYNDROME

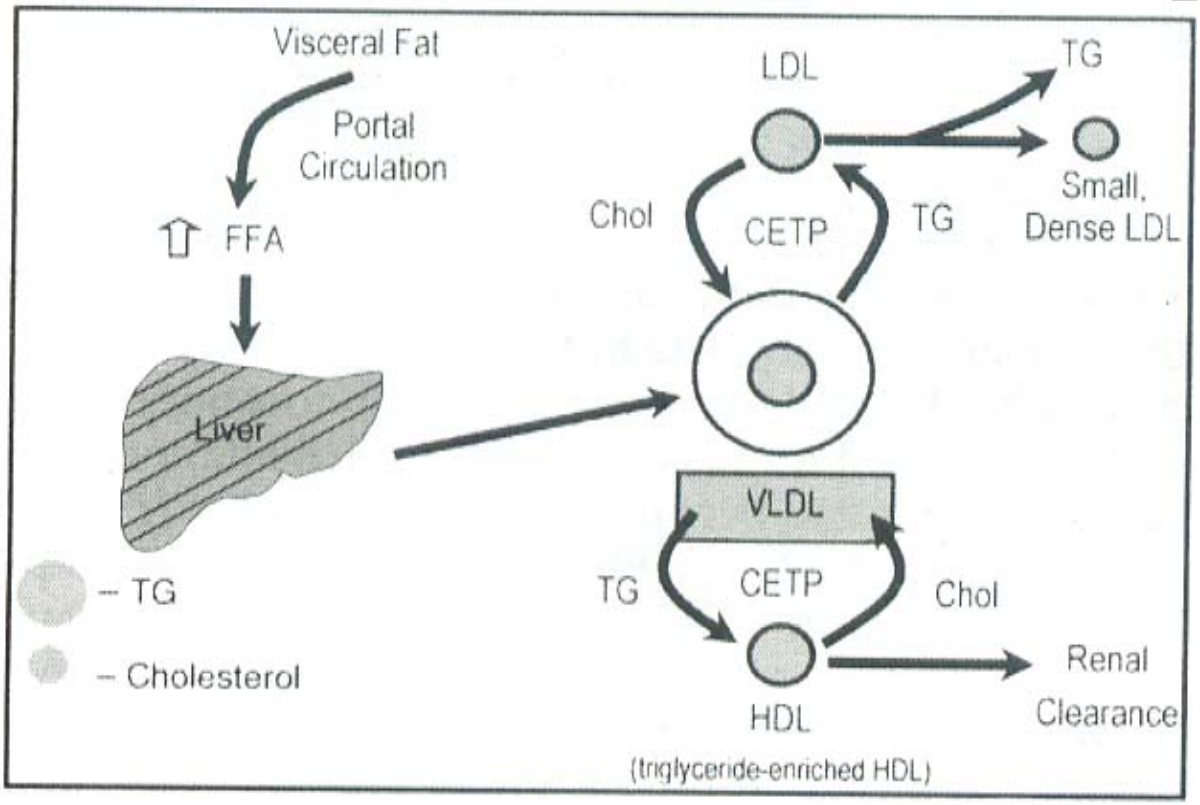
All fat cells are not created equal

- Large insulin resistant Adipocyte
- Increased cytokine production
- Increased release of FFAs
- Site of adiponectin production



- Small Insulin Sensitive Adipocytes
- Little endocrine activity

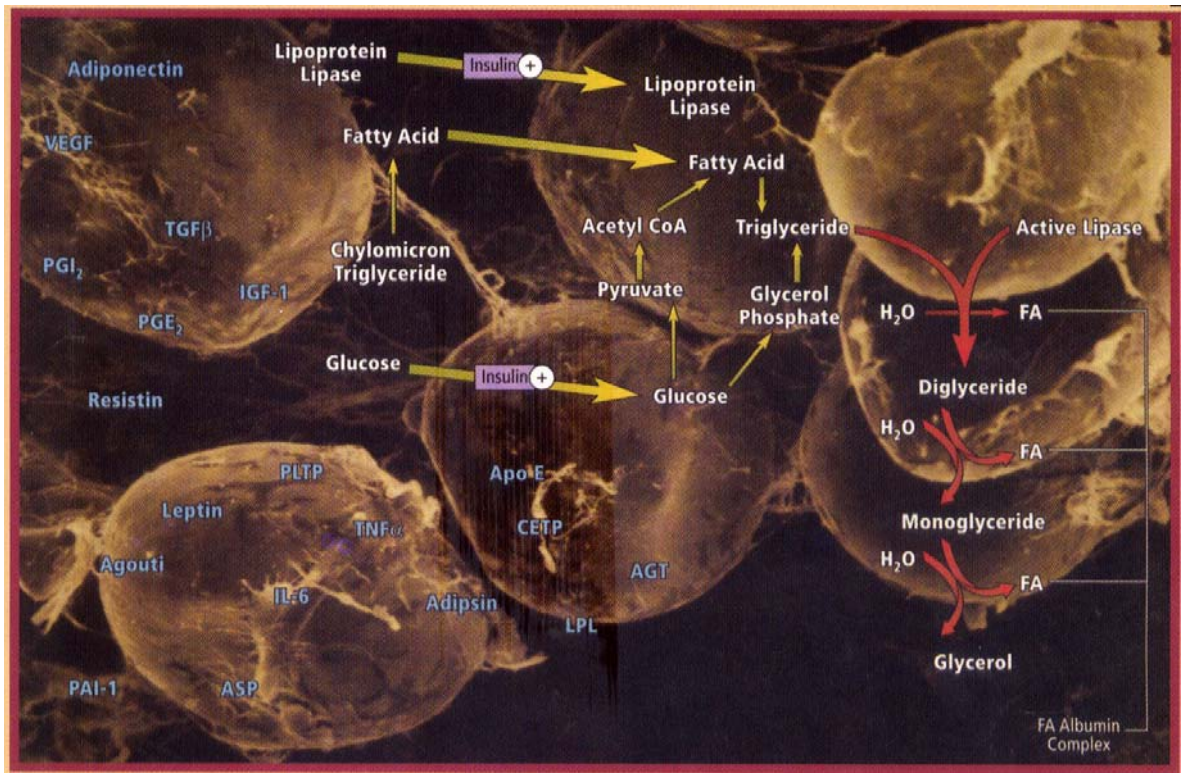
ATHEROGENIC DYSLIPIDEMIA



Relationship between visceral fat and the development of "atherogenic dyslipidemia" characterized by

1) **An increase in small, dense LDL particles**
2) **Elevated levels of VLDL, triglycerides**
3) **Low levels of HDL- cholesterol.**

PATHOGENESIS OF METABOLIC SYNDROME



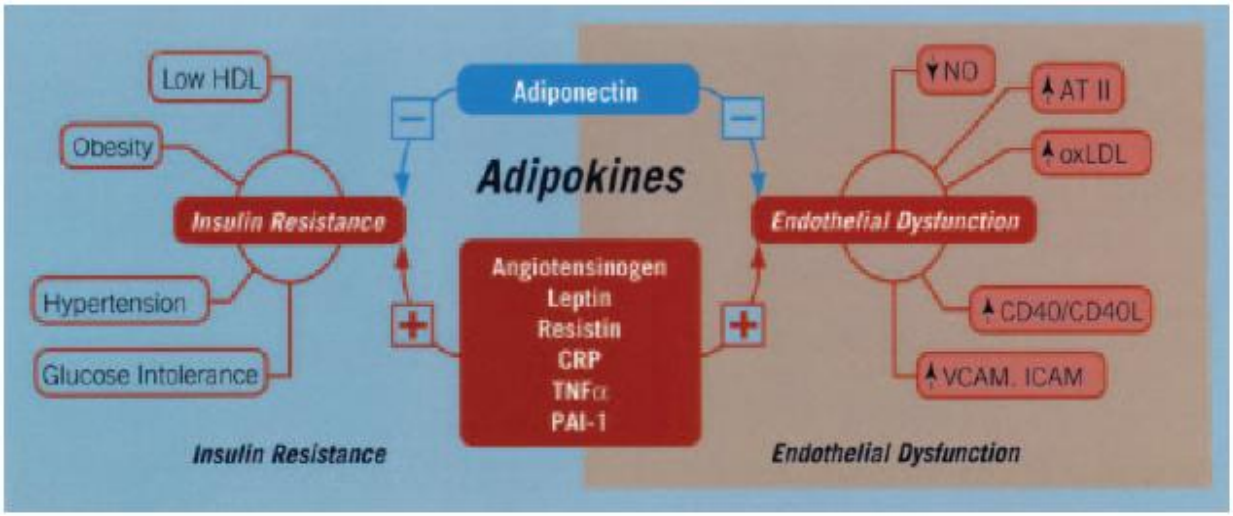


Figure 2. Adipokines link insulin resistance to vascular disease. Adapted from Lau et al.[37]

BMI AND WEIGHT CUT POINT FOR OVERWEIGHT AND OBSEITY AT DIFFEENT HEIGHTS IN ASIAN INDIANS

BMI	Optimum	Overweight	Obsese1	Obese 2
	20	23	25	30
Height in cm	Weight in kg			
146	43	49	53	64
149	44	51	56	67
152	46	53	58	69
155	48	55	60	72
158	50	57	62	75
161	52	60	65	78
164	54	62	67	81
167	56	64	70	84
170	58	66	72	87
173	60	69	75	90
176	62	71	77	93
179	64	74	80	96
182	66	76	83	99
185	68	79	86	103
188	71	81	88	106
191	73	84	91	109
194	75	87	94	113
197	78	89	97	116
200	80	92	100	120

Adapted from NHLBI obesity Task Force, 199859 &

diabetes.com.au/research_obesity.htm Feb 200060

KEY TO MASTER CHART

T - Test

C - Control

		1	2
1.	Domicile	Urban	Rural
2.	Employed	Yes	No
3.	Socioeconomic status	High	Low
4.	Life style	Sedentary	Non sedentary
5.	Diet	Vegetarian	Non vegetarian
6.	Tobacco smoking	Present	Absent
7.	Personality type	A	B
8.	Menstrual status	Premenopausal	Postmenopausal
9.	HT	Present	Absent
10.	DM	Present	Absent
11.	CVA	Present	Absent
12.	OCP use	Present	Absent
13.	Family History	Present	Absent
14.	MS_1 (IDF)	Present	Absent
15.	MS_2 (ATP III)	Present	Absent

HT	-	Hypertension
DM	-	Diabetes Mellitus
CVA	-	Cerebrovascular Accident
OCP	-	Oral Contraceptive Pill
F/H	-	Family History
Ht	-	Height
Wt	-	Weight
BMI	-	Body Mass Index
W.C	-	Wasit Circumference
H.C	-	Hip Circumference
W/H	-	Waist Hip Ratio
B.P	-	Blood Pressure
FBS	-	Fasting Blood Sugar
PPBS	-	Post Prandial Blood Sugar
TC	-	Total Cholesterol
TGL	-	Triglyceride
HDL	-	High Density Lipoprotein
VLDL	-	Very High Density Lipoprotein
LDL	-	Low Density Lipoprotein
EF	-	Ejection Fraction
MS_1	-	Metabolic Syndrome (IDF)
MS_2	-	Metabolic Syndrome (ATP III)